# EARLY WARNING TRAINING MODEL DEVELOPMENT EARTHQUAKE WITH INTERNET OF THINGS BASED ON SETS VALIDATION

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The goal of this research is to create an earthquake early warning training model using the internet of things (IoT) based on SETS (Science, Environment, Technologies, Social). The research began with the development of an IoT-based early warning tool that uses Android as a mode of public dissemination of earthquake events. When the application is finished, it is incorporated into the earthquake early warning training material, where the training model employs SETS. This training model aims to increase community preparedness and vigilance in order to save themselves when earthquake information is disseminated by the created application. The study's findings enabled the development of an earthquake early warning application called Ewae, as well as the training of the community using a SETS-based training model. The model development results in six new syntaxes: a) Organization and Orientation, b) Concept formation, c) Application introduction, d) Simulating applications, e) Disaster response, and f) Training evaluation. The Ewae application's output includes model books, instructor manuals, and participant handbooks.

**Keywords: IoT, SETS, Training, Earthquake**

## Introduction

Earthquakes are more than just a natural occurrence. Earthquakes are even mentioned several times in the Qur'an as an important theme that humans must be aware of because the impact of earthquakes can destroy human civilization. In the letter Al Zalzalah verses 1-8, Allah SWT describes the phenomenon of earthquakes as the end (ending) of the long story of the universe's existence.

In some verses of the letter, Ali Imran mentions the earthquake. Such as the story of how the people of Thamud (Qur'an 7:78), Shu'aib (Qur'an 7:91, 29:37), and Moses (Qur'an 7:155), who denied the existence of God and rejected His messenger (Prophet's treatise), were suddenly destroyed by a natural disaster in the form of an earthquake. Allah SWT also explains in Surat An-Nahal verse 26 the inability of human science to predict the occurrence of earthquakes: their occurrence is immediate (unpredictable), followed by the destruction of buildings that were hit and resulted in loss of life (Qur'an 16:26).

The preceding fact is unarguable because the advancement of science and technology in earthquake forecasting is still in its early stages, and the technology produced is far from complete. Even developed countries that conduct earthquake research, such as the United States, Japan, China, Russia, Turkey, Italy, and Germany, have not been able to accurately predict earthquakes. In contrast to tsunamis, technology for predicting disasters that typically accompany earthquakes has begun to provide

accurate information on the presence of tsunamis. In fact, various institutions, including Indonesia, have widely adopted the technology.

No detection device can accurately predict where an earthquake will occur, when it will occur, or the magnitude of the earthquake. It can be determined that if an earthquake-affected area is unable to provide an early warning system to the community in order for them to immediately evacuate to a comfortable and safe location, then the death and destruction caused are not just a series of small numbers. Indonesia is an earthquake-prone country due to its geographical location in the tectonic zone, which is flanked in the south by the European Asia-Australia plate and in the east by the Pacific and Philippine plates, both of which are very active. The plate shift has the potential to cause an earthquake process that begins at a depth and spreads along the fracture/fault.

The stability of seawater is disrupted vertically or horizontally if the fracture field occurs on the seabed. The risk of earthquakes in Indonesia grows in proportion to the number of people living in danger zones. Since the 1950s, Indonesia's population has grown tenfold, increasing the risk of natural disasters tenfold. According to data from the National Disaster Management Agency, the number of incidents for all types of disasters increased by 6.73 percent from the previous year through November 2018. The disaster occurred 2,021 times out of a total of 2,157 times. Meanwhile, the number of people who have died or gone missing has risen by 1,418.48 percent, from 276 in 2017 to 4,191 in 2018. The number of people injured in 2018 increased by 700.82 percent from 858 in 2017 to 6,871 in 2018. The earthquake in Lombok, as well as the earthquake and tsunami in Central Sulawesi, donated the majority of the victims. The magnitude of losses and deaths caused by earthquakes should not be underestimated, but must be taken seriously. It must be admitted that preventing earthquakes with human hands is impossible.

However, humans must take precautions to reduce losses, particularly the loss of human life that can occur when the earth is jolted by an earthquake. Installing an early warning system is a series of systems used to inform people about natural disasters such as earthquakes. Early warning to the community for disasters is a set of actions that can take the form of a siren sound, an alarm, SMS, and various modes of information that are simple to understand and capable of informing the public.

Early warning can take the form of providing information, which can be in the form of sound, images, data, and various other media that the general public can understand. Simple methods of communicating this information include sirens, gongs, calls to prayer, prayer prayers, drums, and so on. The point is that disaster-related information can be received immediately, and the community can take immediate action to save itself.

All early warning models result in the desire of institutions or authorities to respond quickly to disaster warnings. Because of the limited time and rapid escalation of disasters, the community must not be careless in taking appropriate action when a disaster strikes. When a disaster strikes, early warning should not be delayed, and the public should not be left in the dark. According to Law No. 24 of 2007, early warning is a series of activities carried out by a state-appointed institution to provide immediate warning to the public about the possibility of a disaster occurring in an area. According to the preceding regulation, it is the government's responsibility to provide early warning through an authorized institution. Furthermore, BMKG (Meteology and Geophysics Agency) other community efforts in the form of developing early warning must be developed so that the worst risk of an earthquake can be minimized.

The researchers created an IoT-based earthquake early warning tool, which is related to the title of this dissertation. Earthquake early warning is made in the form of an Android application called Ewae (Early warning System Eartquaeke), where when an

earthquake occurs, people in the vicinity of the earthquake who have earthquake sensors installed and have downloaded the application will be warned by their smartphones to immediately save themselves. Because the technology developed is still relatively new, IoT-based earthquake early warning must be introduced and taught to the public in the form of training in order to reduce the worst risk when an earthquake occurs. Training on the use of Ewae as an earthquake early warning system is required so that people are familiar with the earthquake warning signs and are prepared to save themselves to a safe location. No matter how good an early warning system is, it is useless unless the community is aware of disaster response procedures.

The application training is part of an effort to improve community preparedness for earthquakes by guiding early earthquake warnings as self-rescue instructions. Training in earthquake preparedness is essential for all community groups. According to article 1 paragraph 07 of Law Number 24 of 2007, Disaster Management, preparedness is a series of activities carried out to anticipate disasters through organization and appropriate and efficient steps.

One effort that can be made to improve community preparedness is early warning training for earthquake disasters. The United Nations Office for Disaster Risk Reduction/UNISDR (2015) defines preparedness as an ability or skill and knowledge developed by the government, disaster-related institutions, communities, and individuals. Meanwhile, Gardner (1981) in Nugroho (2008) defines training as "the techniques and arrangements for fostering and experiencing learning." "The emphasis is on learning."

According to Gardner's statement, the training was more focused on learning activities. As a result, training activities are more focused on increasing participants' knowledge, skills/skills, and attitudes. Understanding the ability to mitigate, adapt, and respond to disasters necessitates a contextual training model involving the environment as the primary source of learning in order for this early warning training to maximize awareness and alertness to disasters. The Science, Environment, Technology, and Society (SETS) vision training model is one of the training models that uses the environment as a learning resource. The SETS model has features that link science to other elements, such as technology, the environment, and society (Binadja, 2005).

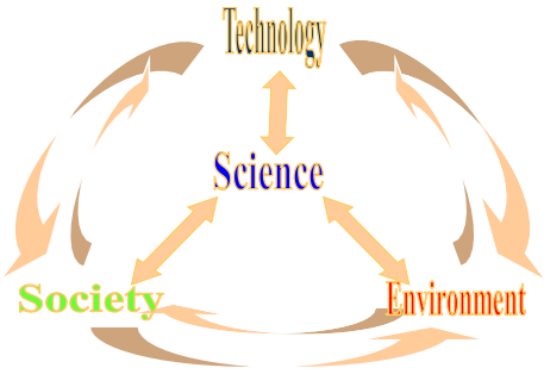


**Figure 1 The relationship between the elements of SETS (Binadja, 2007)**

This article will explain how an earthquake early warning training model was created using an Internet of Things (IoT)-based application called Ewae ver 1 based on SETS, which can be downloaded from the Google Play store. The model's development results are then validated by experts in the field.

## Method

The ADDIE (analysis, design, development, implementation, and evaluation) model was used in this study. This paper, on the other hand, was included in the model development stage, which included expert validation. A questionnaire was used as the research instrument in this study. The Akien V test was used to analyze data for product validation. This study included ten experts, including linguistic experts, learning media experts, and curriculum and material experts. The validators were asked to provide scores and suggestions for improvement in relation to the designed learning model and learning set. The names of the validators involved in validating the researcher's product are listed in table 1.

Table 1 List of Validators' Names and Their Specialty

| No. | Name | Specialty |
|---|---|---|
| 1. | Prof. Dr. Atmazaki, M. Pd | Linguistics |
| 2. | Prof.DR.Ambiyar,M.Pd | Evaluation and Learning Model |
| 3. | Dr. Fahmi Rizal, M.Pd | Curriculum and Learning Model |
| 4. | Dr. Rusnardi, M.T | Material dan Applications |
| 5. | Dr. Prima Yene Putri MT | Materials and Learning Model |
| 6. | Dr. Hansi Efendi ST, M.Kom | Applications |
| 7. | Riki Mukhaiyar, S.T, M.T, Ph.D, | Applications |
| 8. | DR Arif, M.Sc | Applications |
| 9. | Dr. Ihsan | Data Statistic |

## Result and Discussion

This research yielded two products. First, the Early Warning Earthquake (Ewae) Android-based Early Warning Application is an earthquake detection application that is linked to sensors to detect an earthquake. If an earthquake occurs in the location detected by the sensor, this application will notify the user via an alarm.

The sensor used to detect earthquakes is made up of accelerators that are installed in three different locations. If the gradient or surface slope changes slightly, the sensor will send a signal to the LORA transmitter. If all three sensors send the same signal, the LORA transmitter will send a signal to the Android to activate the Ewae application in the form of an alarm sound, allowing users who download Ewae to immediately rescue the earthquake disaster.

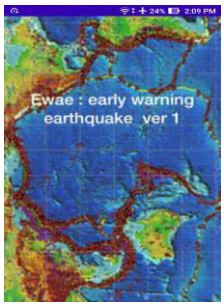


**Figure 2 Initial View of Ewae**

Second, the development of an Earthquake Early Warning Training Model with IoT based on SETS (Science, Environment, Technologies, and Social), in which training participants are taught to respond quickly when the android rings in order to save themselves.

Six syntaxes were used in the development of the SETS-based early warning training model, including:

Table 1 New Development of SETS Syntax

| Stage | Step | Activity |
|---|---|---|
| One | Organization and Orientation | Link<br>Observe |
| Two | Concept Formation | Gathering Information<br>Ask |
| Three | Application Introduction | Associate<br>Communicating |
| Four | Simulate Apps | Prepare<br>Demonstrate |
| Five | Responding to disasters by App | Take appropriate self-rescue measures |
| Six | Evaluation | Evaluate / Assess based on understanding, response, critical thinking, creative, collaborative, and communicative |

A. Novelty

1. Researchers created an Internet of Things-based early warning system using two sensors placed far apart in this study. To avoid misinformation, the two sensors must transmit information about an earthquake at the same time to avoid shaking caused by animals, wind, and other factors.
2. As shown in the table below, previous researchers developed SETS Syntax on various earthquake early warning training models.

| Anna (2010) | Andry, dkk. (2014) | Researcher Synthesis |
|---|---|---|
| Initiation/invitation | Initiation | Organization and Orientation |
| Concept formation | Concept Formation | Concept Formation |
| Concept application | Problem solving | Application Introduction |
| Concept consolidation | Concept Consolidation | Simulate Apps |
| Evaluation | Evaluation | Respond to application |

| | | |
|---|---|---|
| | | Evaluation |

3. This study was successful in developing four products that earthquake early warning training instructors can use. (1) Ewae Ver 1 earthquake early warning application; (2) Earthquake Early Warning Model Book Using SETS-Based IoT; (3) Instructor Handbook for Earthquake Early Warning Training With IoT; and (4) Handbook of Earthquake Early Warning Training Participants.
4. This study's findings also produce supporting components that strengthen the SETS-based training model, which has a significant impact on community awareness of the threat of earthquakes in the form of social, instructional, and accompaniment impacts.

**Analysis of Product Validation**

A. Validation of Learning Model Book

Table 2 shows the results of the validation of research findings as outlined in the SETS-Based Earthquake Early Warning Training Model Book.


**Gambar 3. The Figure of Learning Model Book**

| No. Item | Score V Aiken | Description | Assessment Aspect Results |
|---|---|---|---|
| Item 1 | 0.80 | Valid | Organizational Aspect 0.87 (Valid) |
| Item 2 | 0.88 | Valid | |
| Item 3 | 0.84 | Valid | |
| Item 4 | 0.80 | Valid | Format Aspect 0.90 (Valid) |
| Item 5 | 1.00 | Valid | |
| Item 6 | 0.90 | Valid | |
| Item 7 | 0.86 | Valid | |
| Item 8 | 0.96 | Valid | |

**Table 2 Summary of Validation Results on the Training Model Book**

**Earthquake Early Warning With SETS-Based IoT**

According to the validator's two validity test results, they are: 1) Organizational Aspects with an average score of 0.87 with valid categories, and 2) Format Aspects with an average value of 0.90 with valid categories.

a. Validation of the Training Guide For Instructors

**Figure 4. Instructor's Manual**

Table 3 shows the results of validators' research on the SETS-Based IoT Early Warning Training Model Book.

Table 3. Summary of Validation Results against the Instructor's Handbook

| No. Item | Score V Aiken | Description | Assessment Aspect Results |
|---|---|---|---|
| Item 1 | 0.92 | Valid | Organizational Aspect 0.86 (Valid) |
| Item 2 | 0.93 | Valid | |
| Item 3 | 0.84 | Valid | |
| Item 4 | 0.80 | Valid | |
| Item 5 | 0.92 | Valid | |
| Item 6 | 0.92 | Valid | |
| Item 7 | 0.92 | Valid | Format Aspect 0.92 (Valid) |
| Item 8 | 0.93 | Valid | |
| Item 9 | 0.92 | Valid | |
| Item 10 | 0.92 | Valid | |
| Item 11 | 0.93 | Valid | |
| Item 12 | 0.82 | Valid | Material Aspect 0.82 (Valid) |
| Item 13 | 0.80 | Valid | |
| Item 14 | 0.82 | Valid | |

According to Table 3, the results of the validity test on the Instructor Implementation Guidebook are categorized as valid because the average value is greater than 80 in terms of organization, format, and material.

b. Training Participants' Guide


**Figure 5. Training Participants' Manual**

Table 4 shows the results of the validator's research on the Computer Network Engineering Material Book.

Table 4. Summary of Validation Results on the Guidebook for Earthquake Early Warning Training Participants

| No. Item | Skor V Aiken | Ket. | Hasil Aspek Penilaian |
|---|---|---|---|
| Item 1 | 0.95 | Valid | Organizational Aspect 0.86 (Valid)) |
| Item 2 | 0.90 | Valid | |
| Item 3 | 0.90 | Valid | |
| Item 4 | 0.80 | Valid | |
| Item 5 | 0.80 | Valid | |
| Item 6 | 0.80 | Valid | |
| Item 7 | 0.85 | Valid | Format Aspect 0.86 (Valid) |
| Item 8 | 0.90 | Valid | |
| Item 9 | 0.85 | Valid | |
| Item 10 | 0.95 | Valid | |
| Item 11 | 0.90 | Valid | |
| Item 12 | 0.80 | Valid | |
| Item 13 | 0.80 | Valid | |
| Item 14 | 0.90 | Valid | Material Aspect 0.85 (Valid) |
| Item 15 | 0.90 | Valid | |
| Item 16 | 0.80 | Valid | |
| Item 17 | 0.85 | Valid | |
| Item 18 | 0.85 | Valid | |
| Item 19 | 0.80 | Valid | |
| Item 20 | 0.80 | Valid | |
| Item 21 | 0.85 | Valid | |
| Item 22 | 0.85 | Valid | |
| Item 23 | 0.90 | Valid | |

The image below depicts the validation of the Development of an Earthquake Early Warning Model with SETS.


**Table 5. Table of Validity of Research Products Development SETS-Based IoT Early Warning Training Model**

Table 5 summarizes the assessment of the research product's validity based on the SETS-Based IoT Early Warning Training Model. The obtained results are significant enough to be classified as valid for use as a training model for communities in earthquake-prone areas in order to reduce the worst risk of an earthquake disaster.

## Conclusion

Based on the data analysis and discussion, the following conclusions can be drawn from the research and development of the SETS-Based Earthquake Early Warning Training Model with IoT:

1. The following is the syntax of a SETS-Based Earthquake Early Warning Training Model: a) Organization and orientation b) Concept formation c) Application introduction d) Simulating applications e) Disaster response f) Evaluation of training.A valid SETS-Based IoT Early Warning Training Model is generated.

2. The Ewae application, model books, instructor books, and participant handbooks are examples of research products that can be used to raise awareness and vigilance about earthquake disasters.

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